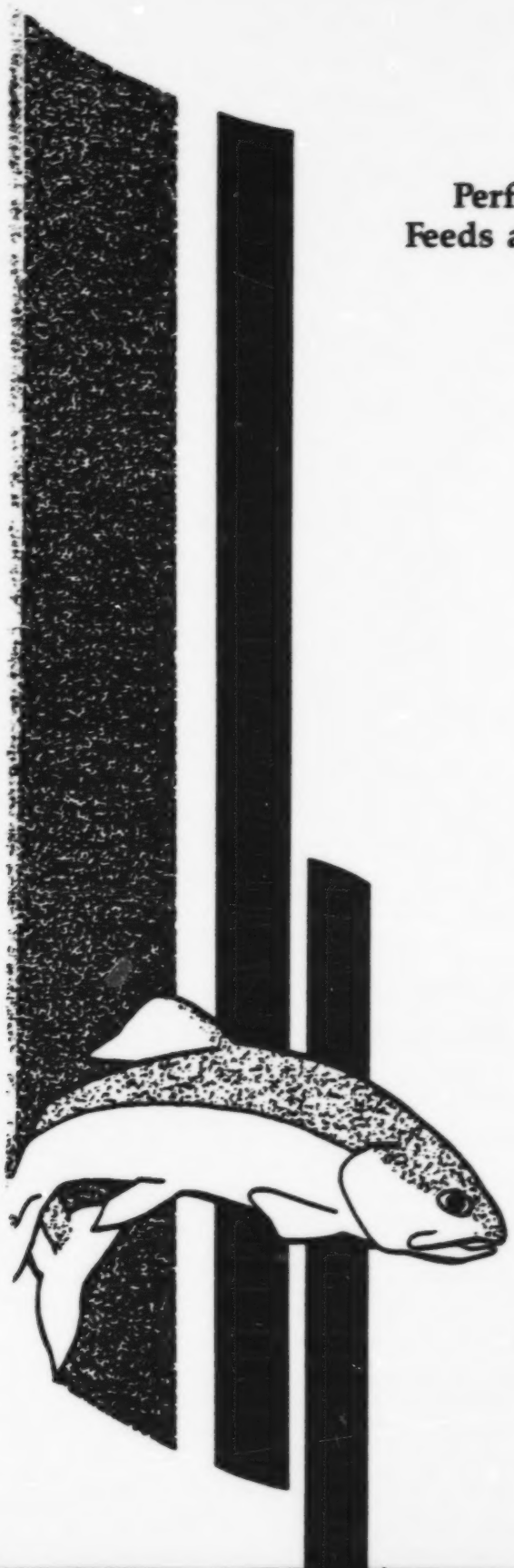

Performance of Trout Fed a Variety of Feeds at British Columbia Trout Hatcheries 1985 - 1987

by

BRYAN W. LUDWIG
DAVID R. CLOUGH

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PERFORMANCE OF TROUT FED A VARIETY OF FEEDS AT BRITISH COLUMBIA TROUT HATCHERIES 1985 - 1987

By

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ABSTRACT

Ludwig, Bryan W. and David R. Clough. 1989. Performance of trout fed a variety of feeds at British Columbia trout hatcheries, 1985-87. Fisheries Management Report No. 93. 22 p.

The dietary performance and cost efficiency of production diets currently used for culturing trout at Provincial trout hatcheries were compared to several other diets available in British Columbia. Seven studies were conducted over three brood years at three different hatcheries. Six starter diets (BioDiet, Silver Cup Softmoist, Oregon Moist Pellet (O.M.P.), Ewos and Rangen's Softmoist) and three grower diets (BioDiet, Silver Cup and BioMoist) were tested. Of the starter and grower diets tested, BioDiet and BioMoist resulted in the best performance in terms of survival and production, while for the grower diets, Silver Cup provided the lowest cost per kg of fish produced. Several other diets including O.M.P., Ewos and Rangen showed promise but require further testing. BioDiet was recommended as the starter feed. Based strictly on production costs, the recommended grower feed would be Silver Cup, but a final recommendation cannot be made until a comparison of the relative survival in lakes for fish fed BioDiet and Silver Cup is completed.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the work of the staff at Fraser Valley, Kootenay and Summerland Trout hatcheries, in particular P. Brown, D. Crawley, K. Hoffman, J. Klimek, D. Larson, L. Siemens and M. Siemens for feeding and caring for the fish and conducting sample counts. G. Sutcliffe prepared the figures; J. Lum, G. Johnson and R. Wymenga typed the manuscript. P. Slaney reviewed the manuscript and provided many helpful suggestions.

INTRODUCTION

Currently in British Columbia, two feeds serve as the production diets for trout in Provincial facilities. BioDiet manufactured by Bioproducts Inc. in Oregon is primarily used as a starter feed while Silver Cup Salmon feed manufactured by Murray Elevators in Utah is used as a grower feed. These diets are used in the production of steelhead, cutthroat, rainbow, Dolly Varden, brook trout, brown trout and kokanee. Since both of these diets are manufactured in the United States, the costs are higher due to shipping, duty, brokerage and dollar exchange.

In response to the developing aquaculture industry, a number of new salmonid diets are now manufactured or distributed in British Columbia including: Ewos, manufactured by Ewos Canada, Surrey, and New Age Trout and Salmon Feed, distributed by Moore-Clark Co., Vancouver. In addition, two more manufacturers have recently introduced semi-moist feeds: Murray Elevators and Rangens Inc., Idaho. The Ministry of Environment, Recreational Fisheries Branch has an on-going program of evaluating new diets to ensure that Provincial facilities continue to produce high quality trout in the most cost-effective manner. This report examines the performance of starter and grower diets fed to wild trout stocks at Provincial hatcheries over the period 1985 to 1988.

METHODS

The diet studies were conducted at Fraser Valley Trout Hatchery (FVTH) in Abbotsford, Summerland Trout Hatchery (SLD) in Summerland and Kootenay Trout Hatchery (KTH) in Wardner, British Columbia (Table 1). Each diet study was adapted to site-specific requirements. Where space and manpower allowed, the experiments were kept separate from production rearing. Except for the starter diet study at Summerland, ration levels were set using manufacturer's feed charts as a guideline. The ration level was further refined based on experience at the site and a visual assessment of feed waste in the pond. Feed sizes were adjusted based on manufacturer's recommendations and visual assessment. For the Summerland starter diet study, fish were fed to satiation. Except where noted, the study diets were fed with no adjustment for moisture differences between diets.

Feeding rates were adjusted twice monthly for the grower diet studies and weekly for the starter diet studies. Starter diets were fed every half hour, 16 times per day. Grower diets were fed as often as every half hour to every other day depending on site-specific requirements. Fish growth was measured by bulk

Table 1. Design of Diet Studies at Provincial Hatcheries 1985-1987.

	Diet Stage	Site	Brood & Year	Study Diets	Food Size	Diet Type	Moisture Content %	No. Replicates per Diet	Approximate No. Fish per Diet
a.	Starter	FVTH	Coldwater	BioDiet	St.1-3	semi-moist	21	3	23,100
			1985	Silver Cup	St. 1	dry	8	3	23,100
				O.M.P.	M, 1/32	moist	30	3	23,100
				Bio/S.C.	St.1-2/1	semi-moist/dry	21/8	3	23,100
b.	Starter	FVTH	Tunkwa	BioDiet	St.1-3	semi-moist	21	3	23,100
			1986	Silver Cup	St.1	dry	8	3	23,100
				O.M.P.	M, 1/32	moist	30	3	23,100
				Bio/S.C.	St.1-2/1	semi-moist/dry	21/8	3	23,100
c.	Starter	FVTH	Tunkwa	BioDiet	St.1-4	semi-moist		3	23,100
			1987	Silver Cup	St.1	semi-moist	20*	3	23,100
				Rangen	St.1,2	semi-moist		3	23,100
				Ewos	St.1	dry	9	3	23,100
d.	Starter	SLD	Pennask	BioDiet	St.1-3	semi-moist	20*	1	50,000
			1987	Silver Cup	St.1,2	semi-moist		1	50,000
e.	Grower	FVTH	Tunkwa	BioDiet	G1.3-2.5	semi-moist	21	1	50,000
			1987	Silver Cup	G.1	dry	8	1	50,000
f.	Grower	SLD	Pennask	BioDiet	St.3,4 G1.0,1.5	semi-moist	20	1	50,000
			1987	Silver Cup	St. G1,2	dry	8	1	50,000
g.	Grower	KTH	Premier	BioMoist	St.4 G1.3	moist	21 26.5	2	400,000
				Silver Cup	G2	dry	8	2	400,000

*avg. estimate

weight samples (two or three replicates) prior to every feed adjustment. Calculation of the dry ration was based on the moisture content recorded on bag labels for each diet (Appendix Table 1). Dry food conversion was then computed by dividing the dry ration fed by the net weight gained. Growth predictions were made using a growth model developed by Iwama and Tautz (1981). All feeding and sampling methods were performed equally among replicates at all hatcheries. Mortalities were removed and recorded daily.

Comparisons between diets were based on dietary performance and cost effectiveness. Dietary performance was measured by mortality, growth, net production and dry food conversion. Cost effectiveness was measured by computing the cost per kg of fish produced. Where applicable, the statistical significance of values in each category were tested with either a Student T-test ($p<0.05$) or a Student-Newman-Keuls multiple range test ($p<0.05$) (Zar 1984).

STARTER DIET COMPARISONS

Fraser Valley Trout Hatchery Starter Diet Study - 1985 Brood

In 1985, four starter diets were fed to Coldwater River steelhead fry (Table 1a). The study diets were: BioDiet (No. 1-3), Silver Cup Salmon Fry (starter/No. 1) and Oregon Moist Pellet (O.M.P. mash, 1/32), an open formula diet manufactured by Moore-Clarke Co. Inc. (LaConner, Wa.). The fourth treatment was a combination of BioDiet (No. 1/2) for the first three weeks of feeding, followed by Silver Cup (No. 1) for the remainder of the study. The transition between the two diets was carried out over a three day period.

Twelve troughs (three per diet) were loaded with approximately 7,700 fish each. The troughs were 4.9 m long x 0.41 m wide, with a water depth of 0.15 m. Water flows were adjusted from 30 to 110 L/min as required, and water temperature was 13°C.

Feeding rates, which were set weekly, began at 12% body weight per day and were reduced to 5% by the end of the study. Rations were adjusted for the moisture content of the diets such that each treatment received the same ration on a dry weight basis. All diets were hand-fed throughout the study period. The study was conducted from June 20 to August 1, 1985 (seven weeks). At the end of the study 30 fish per trough were measured for fork length and wet weight.

Fraser Valley Trout Hatchery Starter Diet Study - 1987 Brood

In 1987, Tunkwa Lake rainbow trout were again used as the brood source but the study diets were BioDiet (starter, No. 1-4), Silver Cup Soft-Moist (starter, No. 1), Rangen Soft Moist Salmon (starter, No. 1/2) supplied by Lofoten Aqua Supply Ltd. (Victoria, B.C.) and Ewos St40 (starter, No. 1) supplied by Ewos Canada in Surrey, B.C. (Table 1c). The average water temperature was 12.7°C (range 11.5 - 14.0°C).

With the following exceptions, methods were similar to the 1985 starter diet study. Although feeding had actually commenced five days earlier, the study began August 6, 1987 when the fish were first sampled for weight. Feed rates were set weekly, beginning at 10% and ending at 4% of body weight per day. Differences in moisture content between the diets were not compensated for in feed rates. The fry were fed hourly by shaker feeder and by hand. At the end of the eight week study 50 fish per trough were measured for fork length.

Summerland Hatchery Starter Diet Study - 1987 Brood

Two semi-moist starter diets were each tested with approximately 50,000 Pennask Lake rainbow trout (Table 1d). The study diets were Silver Cup Soft-Moist (starter, No. 1/2) and BioDiet Starter (No. 1-3). The treatment groups were reared for four weeks in 325 L troughs, then moved to 900 L tubs. Water flows were adjusted from 30 to 95 L/min as required. The average water temperature was 10.5°C (range: 10-11°C).

The fish were hand-fed to satiation each day. The daily feed rate varied from 2.4% to 24% body weight per day. An undiagnosed disease was prevalent throughout the study in both groups. Hatchery staff suspected bacterial gill disease but laboratory specimens did not confirm the diagnosis so no treatments were applied. The study began July 15, 1987 and ended September 30, 1987 (11 weeks).

GROWER DIET COMPARISONS

Fraser Valley Trout Hatchery Grower Diet Study - 1987 Brood

Tunkwa Lake rainbow trout (100,000) were split into two 21,000 L circular ponds and fed either BioDiet Grower (1.3, 1.5, 2.5 mm), a semi-moist feed, or Silver Cup Salmon Fry and Crumbles (No. 1-4), a dry feed. Prior to the experiment, the fish were fed BioDiet. The groups fed Silver Cup were converted to the new ration over a four-week period. Pond water flow was approximately 500 L/min and the water temperature averaged 9.6°C (range: 7.0 - 11.5°C). Average fish weight at the beginning of the study was

3.3 grams. Ration levels were set initially at 2.4% but were decreased to 0.8% body weight per day (65% of maximum ration) to attain the target size of 10 g at release. Feeding was by automatic feeder and by hand. As the pond density approached maximum on March 15, 1988, each group was reduced to 35,000 fish. The study began November 15, 1987 and ended April 30, 1988 (24 weeks).

Summerland Hatchery Grower Diet Study - 1987 Brood

At Summerland Trout Hatchery (Table 1f), semi-moist BioDiet Starter (No. 3/4) and Grower (1.0, 1.5 mm) were compared with dry Silver Cup Salmon Fry (starter, No. 1/2). Prior to the study, the two groups of approximately 50,000 Pennask rainbow fry were fed an equal mixture of BioDiet and Silver Cup starter diets.

The experiment began October 6, 1987, when the fish were 1.3 g in size. Each test group was held for three weeks in two 900 L troughs, then moved to larger 11,700 L ponds. Water flow varied from 300 to 400 L/min with an average water temperature of 10.5°C (range: 10-11°C). Feeding rates began at 4% body weight per day and were reduced to 0.5% by the end of the study. The feeding rates were intentionally reduced 30% to 50% of maximum due to limited water supplies during the study period, which ended March 15, 1988. At the end of the 22 week study, 100 fish from each diet treatment were measured for fork length and wet weight.

Kootenay Trout Hatchery Grower Diet Study - 1987 Brood

At Kootenay Trout Hatchery, the performance of BioMoist Starter/Grower (No. 4/1.3 mm) was compared to Silver Cup Salmon Fry (No. 1). Prior to the study, four groups of approximately 200,000 fry from Premier Lake were fed starter rations of BioMoist. The two groups to be fed Silver Cup were switched to the new diet over a four-week period. Each replicate was reared in 36,000 L ponds supplied with a water flow of 325 L/min. Average water temperature was 7.8°C (range 7.5-8.0°C). The study began November 15, 1987, when the fish weighed an average of 1.6 grams. Feeding rates varied from 0.7 to 0.9% body weight. The feeding rates were reduced 25 to 35% of the maximum daily ration because of water shortages during the study period. The study concluded April 13, 1988, when the fish were fin-clipped and released into local lakes. At the end of the study 100 fish from each pond were measured for fork length and wet weight.

RESULTS

STARTER DIET COMPARISONS

Fraser Valley Trout Hatchery Starter Diet Study - 1985 Brood

Coldwater R. steelhead fry fed BioDiet had the largest final size (1.2 g) and the lowest mortality rate (2.0%) compared to the other treatments (Table 2a). There were no differences among the groups in variation in length or weight. Total mortality was significantly higher for fish fed Silver Cup (4.4%) versus the other treatments (2.0 - 2.5%)(Table 2a). Mortality rates declined over time in all diet treatments except for the Silver Cup groups, where losses were highest in the third week of the study (Fig. 1). Net production was significantly lower for groups fed O.M.P. (Table 2a). In growth over time, groups fed BioDiet were closest to the formula predicted size (Fig. 2). All four diet groups had low dry food conversions indicating reasonable overall feeding and growth. The net cost per kg produced for Silver Cup ($1.40) was much lower than for the other treatments ($2.51 - $3.80). The BioDiet/Silver Cup replicates showed no noticeable change in mortality rate or growth rate when diets were switched after three weeks from BioDiet to Silver Cup (Figs. 1, 2). Due to a containment screen failure, one of the three B.D./S.C. replicates was reduced to half (3,700 fish) the original number. Consequently, total production reflects the fewer numbers of fish involved.

Fraser Valley Trout Hatchery Starter Diet Study - 1986 Brood

Tunkwa Lake rainbow fed BioDiet, B.D./S.C. and O.M.P. had higher growth rates than those fed Silver Cup. Fish fed BioDiet had the lowest mortality (1.6%) followed by B.D./S.C. (2.0%), O.M.P. (2.2%) and Silver Cup (34.3%)(Table 2b). The likely cause of the high mortalities in the Silver Cup groups was that an outdated bag of starter was inadvertently used early in the study. No disease agents were isolated. There was a trend of decreasing mortality over time in all diet groups except for the Silver Cup replicates, which showed a sharp increase over a four-week period in the study (Fig. 3). The Silver Cup-fed groups had significantly lower net production than the other diet groups (Table 2b) and a higher food conversion. Production cost was lowest for Silver Cup followed by O.M.P., B.D./S.C. and BioDiet. There were no noticeable differences in mortality or growth rates when the BioDiet/Silver Cup diet replicates underwent the transition from BioDiet to Silver Cup after four weeks of feeding (Fig. 3, 4). There were no differences among the groups in variation in length or weight.

Table 2. Results (mean ±1 SD) of Diet Studies at Provincial Hatcheries 1985-1987.

	Diet Stage	Site	Brood & Year	Study Diets	Study Period Weeks	Mean Weight(g) Start	Mean Weight(g) Finish	Amount Fed kg	Net Prod'n kg	Dry Food Conversion	Total Mort. %	Net Cost Per kg $
a.	Starter	FVTH	Coldwater	BioDiet	7	0.13 ±0.012	1.2 ±0.07	30.3	23.3	1.03 ±0.09	2.0 ±0.20	3.80
			1985	Silver Cup	7	0.14 ±0.12	1.1 ±0.07	27.4	21.8	1.12 ±0.06	4.4[1] ±0.42	1.40
				O.M.P.	7	0.14 ±0.006	1.0 ±0.02	29.5	17.8[1*]	1.16 ±0.01	2.4 ±0.51	2.51
				Bio/S.C.	7	0.13 ±0.001	1.1 ±0.03	18.0	14.4**	1.07 ±0.03	2.5 ±0.17	2.63
b.	Starter	FVTH	Tunkwa	BioDiet	8	0.17 ±0.006	1.1 ±0.04	42.4	20.8	1.62 ±0.05	1.6 ±0.17	5.93
			1986	Silver Cup	8	0.16 ±0.009	0.7 ±0.01	18.8	7.0[1]	2.49 ±0.49	34.3[1] ±7.95	3.02
				O.M.P.	8	0.15 ±0.003	1.1 ±0.02	46.0	20.9	1.54 ±0.02	2.2 ±0.34	3.32
				Bio/S.C.	8	0.14 ±0.003	1.0 ±0.04	38.8	18.7	1.80 ±0.06	2.0 ±0.03	4.03
c.	Starter	FVTH	Tunkwa	BioDiet	8	0.17 ±0.006	1.0 ±0.01	30.6	17.4	1.39 ±0.03	1.2 ±0.10	4.34[2]
			1987	S.C. Moist	8	0.15 ±0.002	0.9 ±0.04	29.2	16.1	1.49 ±0.06	1.9 ±0.32	3.41
				Ran. Moist	8	0.15 ±0.002	1.0 ±0.04	28.8	17.0	1.37 ±0.05	2.6[1] ±0.44	3.39
				Ewos Dry	8	0.15 ±0.004	1.1 ±0.02	32.5	19.9[1]	1.52 ±0.05	1.8 ±0.38	3.75[1]
d.	Starter	SLD	Pennask	BioDiet	11	0.14	1.9	93	71.0	1.05	14.6	2.97
			1987	S.C. Moist	11	0.13	1.3	106	45.5	1.86	16.8	4.74
e.	Grower	FVTH	Tunkwa	BioDiet	24	3.3	14.0	547	471	0.93	0.8	2.14
			1987	S.C. Dry	24	3.3	11.5	590	319	1.70	1.2	1.70
f.	Grower	SLD	Pennask	BioDiet	22	1.2	8.0	408	318	1.02	0.9	2.60
			1987	S.C. Dry	22	1.3	8.0	408	310	1.21	1.5	1.37
g.	Grower	KTH	Premier	BioMoist	22	1.6 ±0.04	3.6 ±0.03	1033	758	0.95[1] ±0.03	2.1 ±0.42	1.80[1]
			1987	S.C. Dry	22	1.6 ±0.12	3.9 ±0.29	1033	823	1.13 ±0.03	2.5 ±0.18	1.31

* Values with the same superscript are significantly different from other values ($p<0.05$).

** Compared with only two replicates.

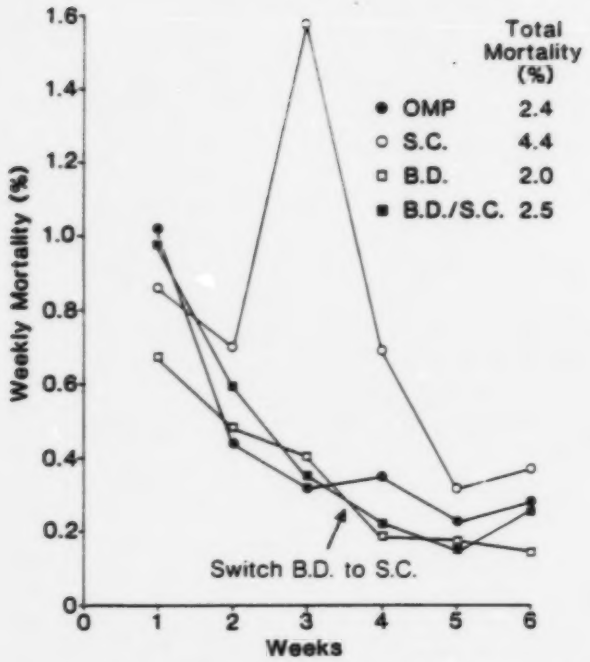

Figure 1 Mortality rates of the 1985 Coldwater River Steelhead brood fed starter diets at Fraser Valley Trout Hatchery

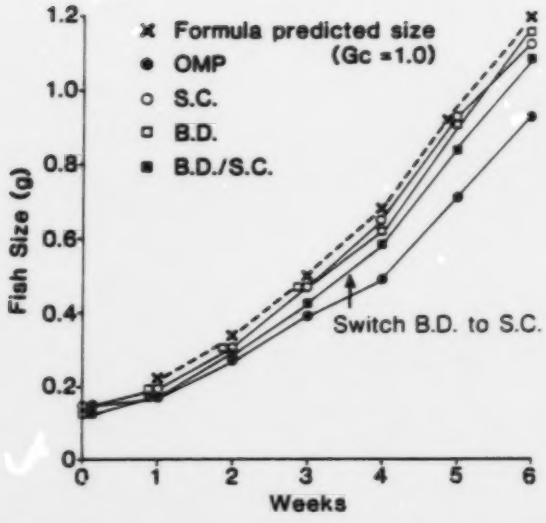

Figure 2 Growth rates of the 1985 Coldwater River Steelhead brood fed starter diets at Fraser Valley Trout Hatchery

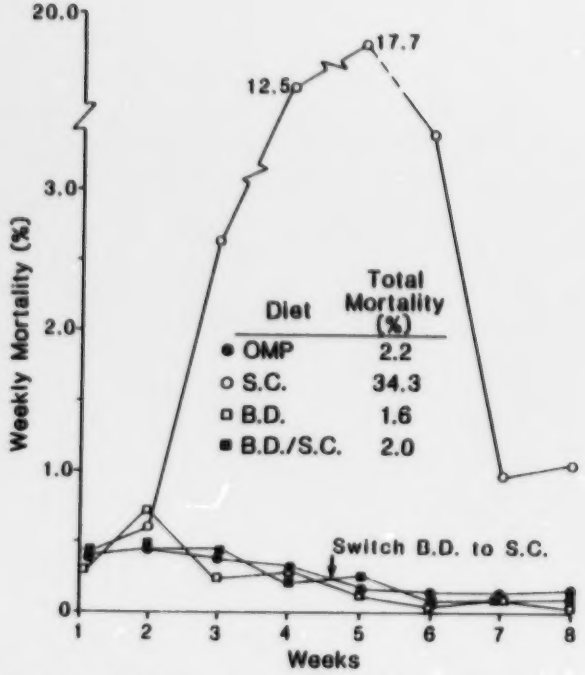

Figure 3 Mortality rates of the 1986 Tunkwa Lake Rainbow brood fed starter diets at Fraser Valley Trout Hatchery

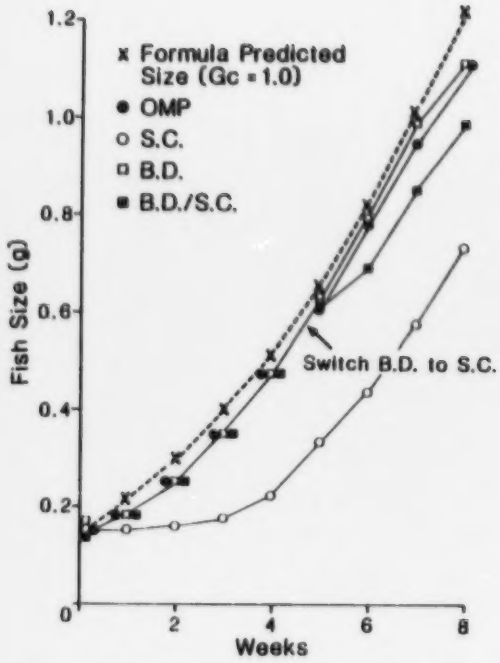

Figure 4 Growth rates of the 1986 Tunkwa Lake rainbow brood fed starter diets at Fraser Valley Trout Hatchery

Fraser Valley Trout Hatchery Starter Diet Study - 1987 Brood

Fish fed Ewos attained the largest final size (1.1 g) followed by BioDiet (1.0 g), Rangen (1.0 g) and S.C. (0.9 g) (Table 2c). Fish fed BioDiet had the lowest losses (1.2%), while the Rangen groups had the highest losses (2.6%). Most of the losses in the Rangen groups occurred in the first week of the study (Fig. 5). Food conversions were not significantly different among treatments. Production costs per kg were highest for BioDiet ($4.34) and lowest for Rangen ($3.35) (Table 2c, Fig. 6). There were no differences among the groups in variation in length.

Summerland Trout Hatchery Starter Diet Experiment - 1987 Brood

Performance of Pennask Lake rainbow fed BioDiet was much better than for those fed Silver Cup Soft-Moist (Fig. 7). Compared to Silver Cup, the BioDiet group had 15% fewer mortalities, 56% greater net production, and 77% greater food conversion efficiency. BioDiet also yielded a 59% lower production cost (Table 2d). The high overall mortality in both groups was likely a result of an undiagnosed disease agent, suspected to be bacterial gill disease (Fig. 8).

GROWER DIET COMPARISONS

Fraser Valley Trout Hatchery Grower Diet Experiment - 1987 Brood

Tunkwa Lake rainbow fed BioDiet had better dietary performance than those fed Silver Cup dry rations, although production costs were higher. The cost of feed per kg gained was $2.14/kg for BioDiet and $1.70/kg for Silver Cup. Although BioDiet was 20% more costly, it yielded 33% fewer mortalities, 26% greater production and 180% greater food conversion (Table 2e). While total mortality rates were not excessive, some losses may be attributed to post-handling stress from marking (Fig. 9). The Silver Cup diet group showed poor growth in the first eight weeks of feeding (Fig. 10). It appeared that the fish had some difficulty switching from a semi-moist starter diet to a dry grower diet. Attempts to improve feeding response by reducing the initial particle size may have assisted in the eventual adaptation to the dry diet. There was no apparent difference in mortality during the feeding difficulties. Feeder malfunctions and unequal starvation periods among groups prior to marking were responsible for slight differences in the total rations fed during the study. Converted to a dry weight equivalent for total rations, fish on BioDiet were fed 20% less than the Silver Cup.

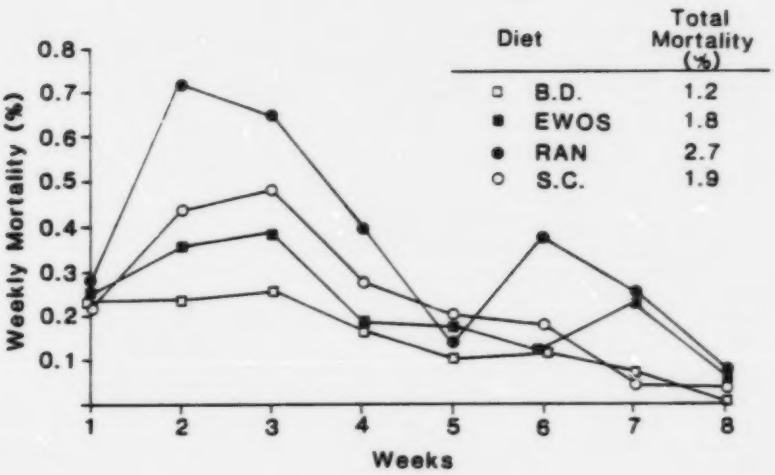

Figure 5 Mortality rates of the 1987 Tunkwa Lake rainbow brood fed starter diets at Fraser Valley Trout Hatchery

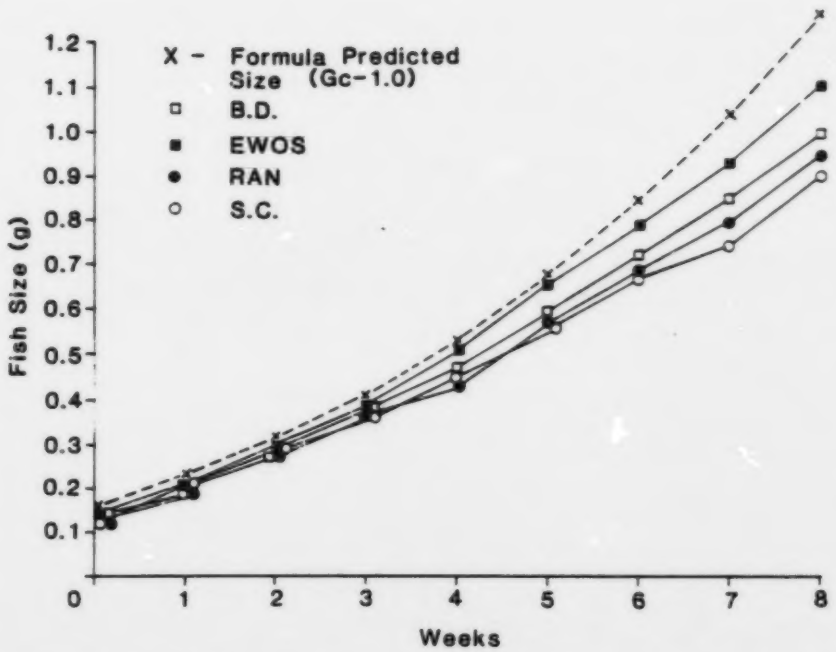

Figure 6 Growth rates of the 1987 Tunkwa Lake rainbow brood fed starter diets at Fraser Valley Trout Hatchery

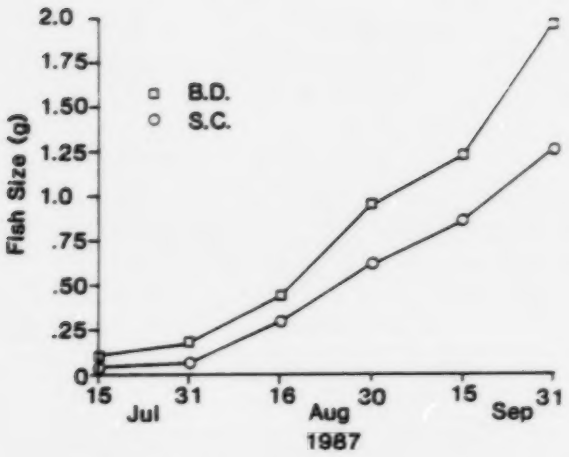

Figure 7 Growth rates of the 1987 Pennask Lake rainbow brood fed starter diets at Summerland Trout Hatchery

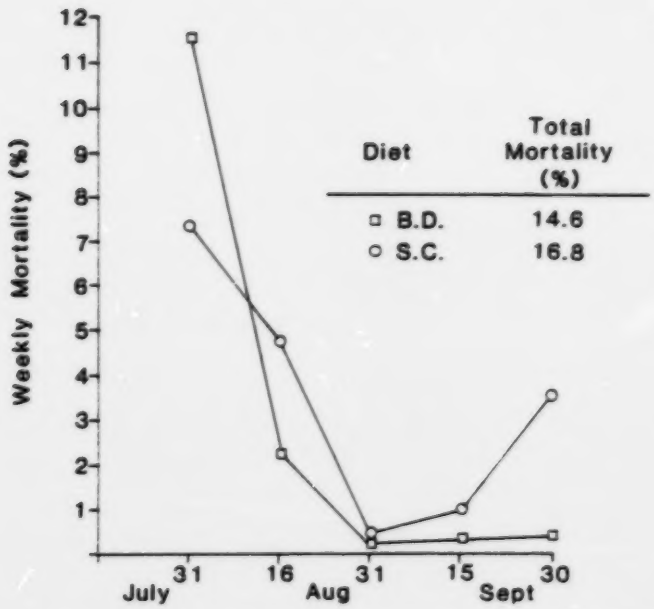

Figure 8 Mortality rates of the 1987 Pennask Lake rainbow brood fed starter diets at Summerland Trout Hatchery

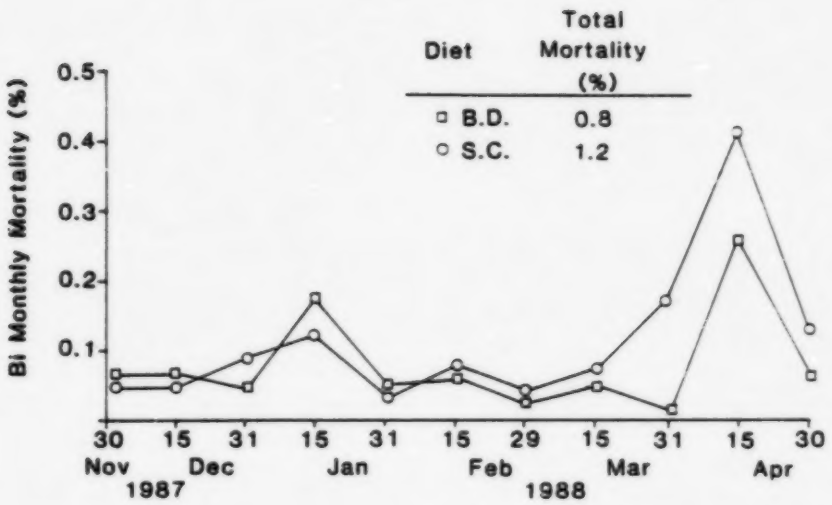

Figure 9 Mortality rates of the 1987 Tunkwa Lake rainbow brood fed grower diets at Fraser Valley Trout Hatchery

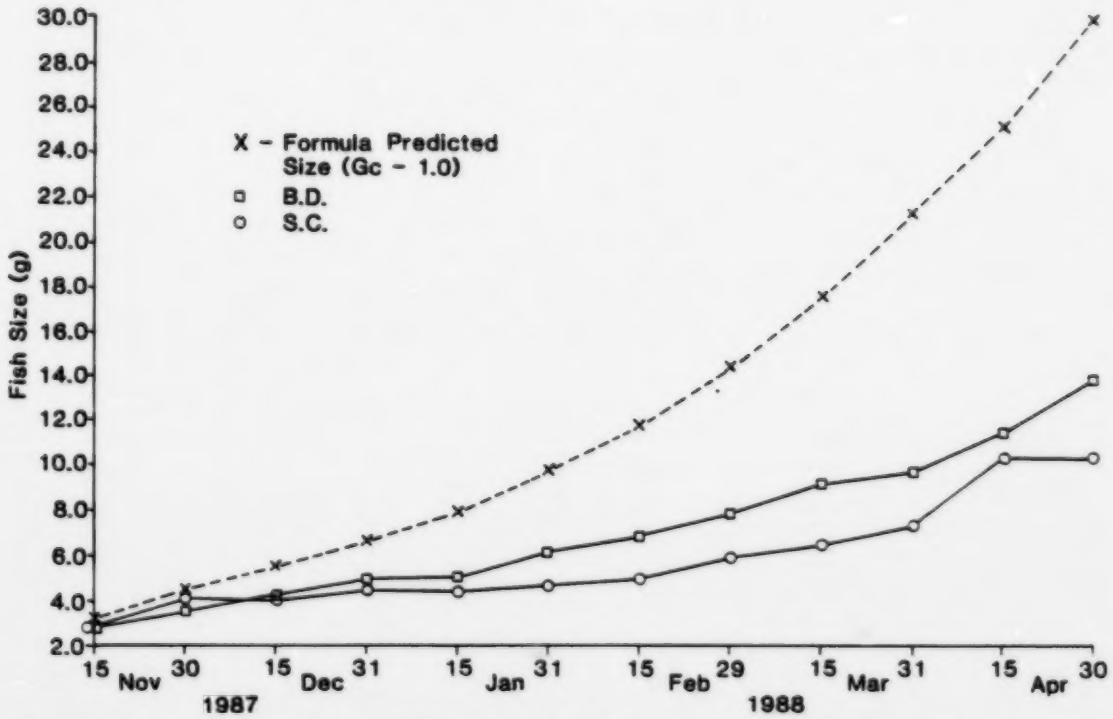

Figure 10 Growth rates of the 1987 Tunkwa Lake rainbow brood fed grower diets at Fraser Valley Trout Hatchery

Summerland Trout Hatchery Grower Diet Study - 1987 Brood

When fed to Pennask Lake rainbow, BioDiet was superior in overall dietary performance compared to Silver Cup. The fish were fed 408 kg of each diet with no compensation for moisture content in feeding rates, resulting in BioDiet being fed 13% less on a dry weight basis compared to Silver Cup. While there was only a 2.5% advantage in net production over Silver Cup, BioDiet had 40% fewer mortalities, and 16% more efficient food conversion. Conversely, the production cost for BioDiet ($2.60/kg) was 90% greater than Silver Cup ($1.37/kg) (Table 2f). Mortalities in both study groups may have been aggravated by the increased loading rate caused by water supply shortages during the winter period (Fig. 11). There was no decline in growth rates observed when the fish were switched from the BioDiet/Silver Cup starter mixture to the separate grower diets at the start of the study (Fig. 12). There were no differences among the groups in variation in length or weight.

Kootenay Trout Hatchery Grower Diet Study - 1987 Brood

Dietary performance for Premier Lake rainbow fed BioMoist feed was superior to those fed Silver Cup dry feed. Each group of fish was fed 517 kg of feed. Since there was no compensation for moisture differences between the feeds, BioMoist was fed 18.5% less than Silver Cup on a dry weight basis. The BioMoist diet groups had 19% greater survival, 10% greater food conversion but 11% less production than the Silver Cup diet group. Production costs for BioMoist ($1.80/kg) were 27% higher than Silver Cup ($1.31/kg) (Table 2g). During the study, one-eyed fish were apparent among both diet groups and although no treatment was applied, mortalities remained low until release (Fig. 13). Growth rates were similar throughout the study period (Fig. 14). There was no observable difference in feeding behaviour after the switch at the beginning of the study from BioMoist to Silver Cup rations. There were no differences among the groups in variation in length or weight.

DISCUSSIONS

The performance of each diet is discussed separately.

Silver Cup

As a starter diet, dry Silver Cup Salmon ration did not perform as well as the other diets (Table 2a, b). Higher mortalities were associated with this diet in both studies,

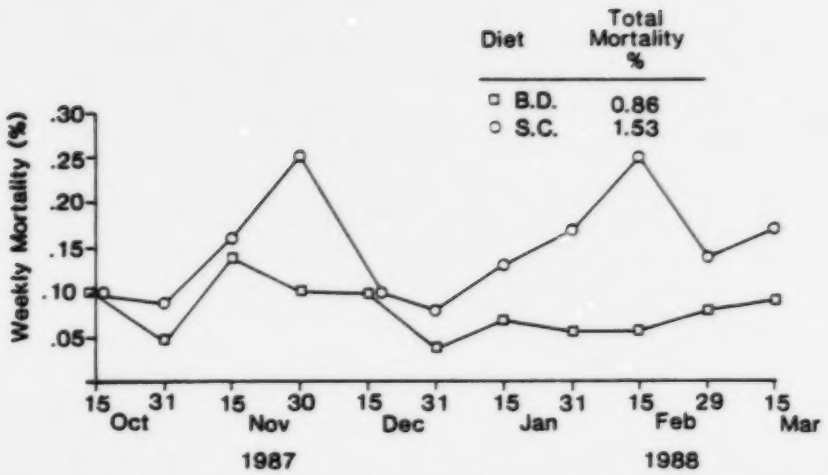

Figure 11 Mortality rates of the 1987 Pennask Lake rainbow brood fed grower diets at Summerland Trout Hatchery

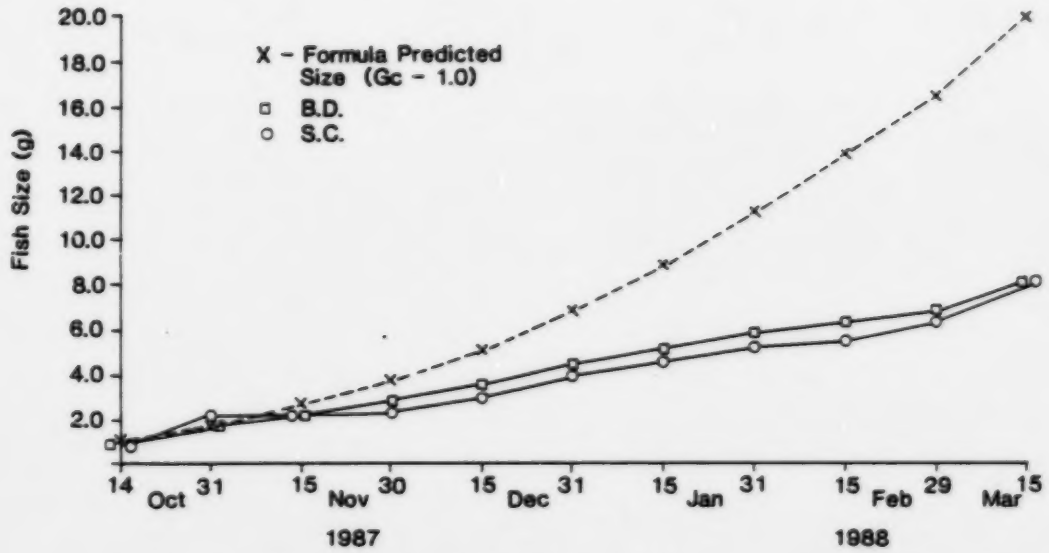

Figure 12 Growth rates of the 1987 Pennask Lake rainbow brood fed grower diets at Summerland Trout Hatchery

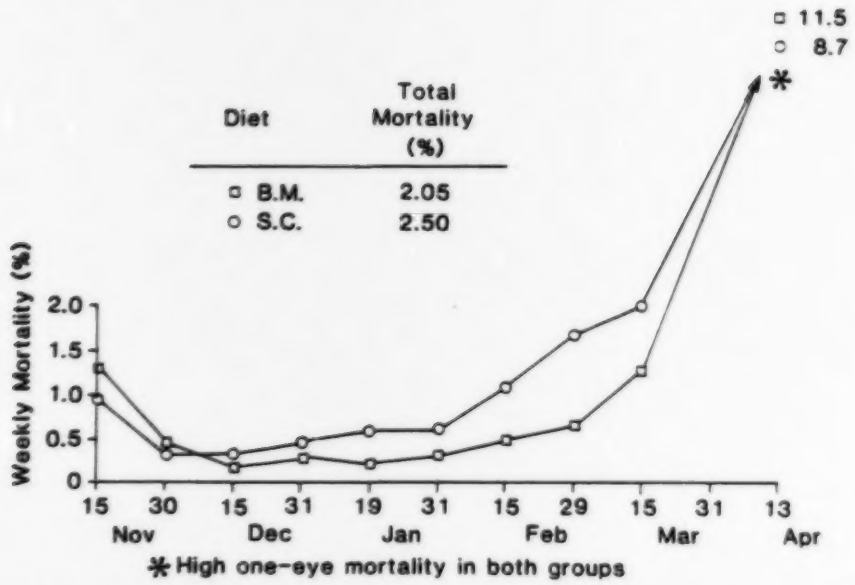

Figure 13 Mortality rates of the 1987 Premier Lake rainbow brood fed grower diets at Kootenay Trout Hatchery

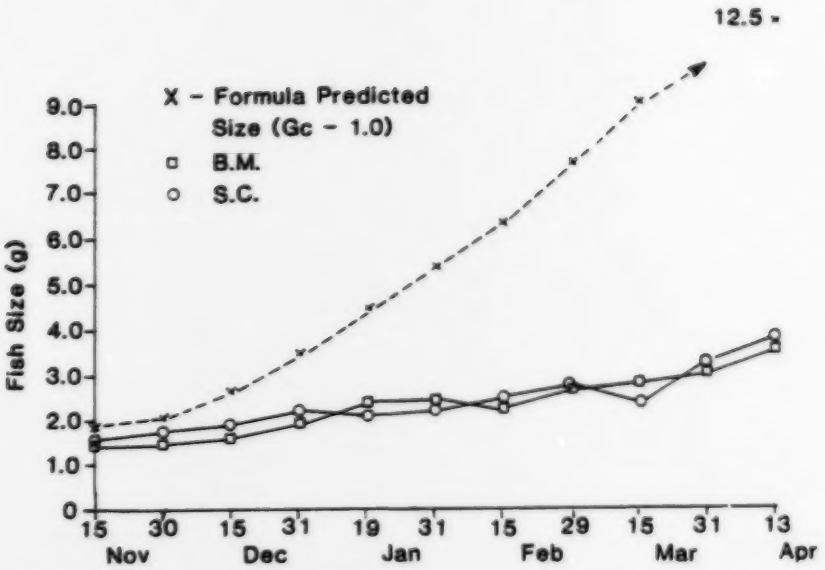

Figure 14 Growth rates of the 1987 Premier Lake rainbow brood fed grower diets at Kootenay Trout Hatchery

although the results of the 1986 study were complicated by accidental use of outdated feed. These results are comparable to those of Lemm and Hendrix (1981), but differ from Shelbourn et al. (1985). Lemm and Hendrix (1981) fed Silver Cup (dry), Rangens, Oregon Moist and BioDiet to Atlantic salmon fry and found poor growth with Silver Cup and superior results with BioDiet. Shelbourne et al. (1985) fed O.M.P. and Silver Cup to chum salmon fry and obtained good results with both diets. BioDiet was not tested in the latter study. The poorer performance of the Silver Cup dry diet may be a result of the lower moisture content in this feed, since low moisture levels can reduce the palatability of the diet for emergent fry (Lemm and Hendrix, 1981; Viola and Smith, 1987).

Silver Cup Soft-Moist ration was recommended by the manufacturer as a semi-moist starter diet for native trout. Unfortunately, due to complications in the studies, results were average to poor compared to other starter diets (Table 2c, 2d). The mixed results in these studies make it difficult to recommend Silver Cup Soft-Moist starter rations, although further testing is warranted.

As a dry grower diet, Silver Cup Salmon rations performed well in two of three comparisons. In all three studies, Silver Cup was the most cost effective diet (Table 2e, 2f, 2g). On average, the net costs per kg for Silver Cup were 33% lower than for BioDiet or BioMoist. Changing from a semi-moist or moist diet to a dry diet may lead to difficulty in feeding due to differences in palatability, taste and texture. At FVTH, there were some difficulties in switching from the BioDiet starter to the Silver Cup grower diet. Results at KTH showed no transition problems in switching from BioMoist to Silver Cup. The discrepancy may be explained by inherent stock differences or possibly that at KTH the fish were switched to the dry diet at a smaller size and younger age.

BioDiet

Based on dietary performance, BioDiet was consistently one of the best starter diets in this study and in several others (Lemm and Hendrix, 1981; Lemm, 1983; Viola and Smith, 1987). BioDiet was always highly ranked in the categories of production and food conversion and in each of the four starter diet studies, the treatment with the lowest mortality was BioDiet. The only category in which BioDiet was not superior was net cost per kg produced. Given the small weight of feed used for starter diets and the fact that the costs are much reduced by switching to a less expensive feed once the fish reach approximately 0.5 g in size, we recommend BioDiet as a starter feed for trout.

In both of the grower diet studies, fish fed BioDiet had the lowest mortality and food conversion. In one of the studies, fish fed BioDiet grew at a higher rate compared to Silver Cup. Production costs for BioDiet were on average 54% higher than for Silver Cup. The higher dietary performance of BioDiet must be

weighed against the high production costs. The results of survival studies in lakes for fish fed the two grower diets will determine if it is cost-effective to use BioDiet as a grower feed.

BioMoist

Results from the grower diet study at Kootenay Trout Hatchery indicated BioMoist had slightly superior dietary performance, but at a 37% higher production cost than Silver Cup (Table 2g). Not calculated in production cost for BioMoist was the additional cost for freezer storage. As well, due to the higher moisture content, there was more difficulty dispensing this diet through mechanical feeders. Considering both grower diet performance and cost, BioMoist may occupy a niche between BioDiet and Silver Cup, and may be a more economic alternative to BioDiet for hatcheries that already have the freezer space necessary to store this diet.

Oregon Moist Pellet

O.M.P. starter diet was tested in 1985 and 1986 at Fraser Valley Hatchery with mixed results (Table 2a, b). Although the same diets and feeding methods were used in both studies, fish fed O.M.P. had the lowest growth rate of the four treatments in 1985, but the highest growth rate in 1986. The difference in performance between years may have been associated with the change in brood stock from Coldwater River steelhead to Tunkwa Lake rainbow, or may be related to rearing temperature. The water temperature for the 1985 study was 13°C versus 9.5°C for the 1986 study and there is some evidence that at least for chum salmon, O.M.P. performs better at cooler water temperatures (Shelbourn et al., 1985).

Because of the high moisture content (30%), O.M.P. is difficult to dispense through mechanical feeders. The high moisture content also means that freezer storage is required, which would increase the overall cost. Selection of O.M.P. as a starter diet will require a facility with adequate freezer space for feed storage, as well as the manpower to rely on hand feeding. As indicated by the results in 1986, O.M.P. starter diet has the capability to perform at least as well as BioDiet, and at a lower cost. Further testing is needed to determine which result is typical of O.M.P.

Ewos

Ewos showed promise as a dry starter diet (Table 2c), although the growth rate was probably somewhat inflated in comparison to the semi-moist diets. This is because the feeding rates were not adjusted for differences in moisture content between diets, thus fish fed Ewos received 15% more feed than the semi-moist diets. Mortalities for fish fed Ewos (1.8%) were lower than for Rangen (2.7%). Ewos has an advantage over moist diets since it is easily dispensed through machine feeders. The advantages of using a dry diet warrant further trials with this diet.

Rangen

Although the net production and dry food conversions for fish fed Rangen were not significantly different from tne other diets, tne mortalities were higher; thus, based on this single test, we cannot recommend this formulation as a starter diet. Further testing is necessary to confirm this result.

SUMMARY

The following summarizes the starter and grower diets that best achieve the desirable criteria of high survival, high production and low production cost (cost per kg of fish produced).

Diet Requirements			Diet Study Results
Starter:	1:	High survival	BioDiet
	2:	High production	BioDiet/Ewos/O.M.P.
	3:	Low production cost	O.M.P.
Grower:	1:	High survival	BioDiet
	2:	High production	BioDiet/Silver Cup/BioMoist
	3:	Low production cost	Silver Cup/BioMoist

Each of the diets in these studies were evaluated on the basis of dietary performance (net production, food conversion efficiency, mortality) and production cost (net gain per kg fed). The importance of these categories will vary depending on program requirements. Given the importance of early growth and development, the key selection criteria for a starter diet should be dietary performance. Since starter diets are used for short periods only, the production costs of premium starter diets such as BioDiet are not inordinately expensive. Extrapolating the results of the 1987 FVTH starter diet study to represent a more typical hatchery production of 100,000 1.0 g fish, demonstrated that the difference in cost between the most productive diet (BioDiet) and the most cost-effective diet (Rangen) was only $90.00 per 100,000 fish. This translates to an extra $0.001 per fish for BioDiet.

For grower diets, although dietary performance must still be the key factor, cost-effectiveness also becomes an important factor in diet selection. Grower diets account for approximately 80% of hatchery food costs. In comparing results of the BioDiet and Silver Cup grower diet study at SLD, although the diets were similar in dietary performance, there were substantial differences in cost. Extrapolation of the grower diet study at Summerland Trout Hatchery indicated a potential cost saving of $972 per 100,000 8 g fish or $0.01 per fish using Silver Cup instead of BioDiet. At FVTH and KTH, there was less difference

in cost between the two diets. At both facilities, the extra cost of using BioDiet at FVTH and BioMoist at KTH versus Silver Cup was $0.004 per fish. The potential cost savings for using the less expensive Silver Cup feed in the Provincial Fish Culture Program for the production of five million yearlings annually would thus be between $20,000 and $50,000 ($0.004 - $0.01 per fish). Although this is a substantial saving, feed cost should not be the only consideration in selecting a grower feed. Fish fed the Silver Cup feed had consistently higher mortalities (20 - 60%) than fish fed BioDiet/BioMoist. Given the higher mortalities, there may be some greater potential for more serious problems to develop among the fish fed Silver Cup, which would quickly increase production costs. Given the overall low mortalities in this study, the likelihood of this developing is unknown. Another key consideration is the relative post release survivals for fish fed the two diets. If the survivals for fish fed BioDiet are higher than for Silver Cup, it may be cost-effective to the overall program to use the more expensive diet. A concurrent study is in place to evaluate the relative survival rates for fish released into lakes, at which time a recommendation will be made as to grower diets for the Provincial Fish Culture Program.

For the grower diet studies, rearing space and water constraints necessitated reducing the ration levels to between 25 and 50% of the maximum as determined by Stauffer (1973). The influence of this reduction on the performance of the diets is unknown. A separate study is needed to determine if the relative performance of the diets would be the same at maximum ration.

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Appendix Table 1. Advertised contents of study diets on manufacturers feed bag labels.

Diet	Manufacturer	Moisture %	Ash %	Fiber %	Fat %	Protein %
BioDiet	Bioproducts Inc. Warrenton, Ore.	21.0	10.5	4.0	16.5	43.0
BioDiet grower	Bioproducts	21.0	11.5	4.0	14.5	43.0
BioMoist starter		21.0	10.5	4.0	16.5	43.0
BioMoist grower		26.5	8.5	4.0	14.5	41.0
Ewos St40 starter*	Ewos Canada Surrey, B.C.	7.5	7.94	-	17.3	51.9
O.M.P. starter		30.0				
Rangen Soft* Moist starter		19.0	7.74	-	22.8	44.8
Silver Cup starter	Murray Elevators	<10.0	<12.0	<3.0	>14.0	>52.0
Silver Cup grower	Murray, Utah	<10.0	<12.0	<3.0	>12.0	>48.0
Silver Cup Soft Moist starter		<18.0	<12.0	<3.0	>16.0	>44.0